

# **Remote-Site Ambient Ozone Data Summary, 2022**

## **Regions 2 and 4, US Forest Service**

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#### **Region 4 Sites**

### **Executive Summary:**

- Surface ozone on the RMRS Region 2/Region 4 network continued a downward trend following the high levels observed during 2020's extreme wildfire events.
- Mixing ratios were relatively benign and did not pose significant risks to vegetation over most of the network. No elevated ozone events (continuously >60ppb) over three days in length were recorded.
- Only four sites (Deadman Pass, Goliath Peak and Briggsdale in Colorado, Snowbird in Utah) recorded design values (fourth-maximum 8-hour daily average) in excess of the 2015 ozone NAAQS of 70 ppb.
- The regulatory three-year design value averages for six sites in the Colorado Front Range (Rocky Mountain NP, Deadman Pass, Briggsdale, Pawnee Buttes, Goliath Peak, and Kenosha Pass) remain above the NAAQS. Three of these, RMNP (Larimer County), Briggsdale and Pawnee Buttes (both Weld County) are in current EPA ozone nonattainment areas.
- Snowbird, UT also remains well above the ozone NAAQS and is within the Salt Lake County nonattainment designation.
- Modest elevated ozone events occurred in mid-April, mid-June, late July, early August and early September. The vegetation hazard from these relatively short-duration events was minimal.

### **I. Changes in the Regulatory Environment**

In February 2020, EPA issued the results of their periodic (every five years) review of the current ozone NAAQS and determined that revision of the NAAQS was not indicated. However, in October 2021, the agency announced they would reconsider this decision. The agency subsequently issued guidance to staff to initiate a new review of the ozone NAAQS, incorporating several recently published studies not included in the 2020 review. The results of the new review have not been published as of this writing.

The status of Colorado Front Range, Wasatch Front, and Uinta Basin nonattainment areas remained unchanged in 2022.

## II. Network Performance, Changes and Updates for 2022:

No new sites were established in 2022, and no sites were decommissioned. The Hebron Slough site (Jackson County, CO) completed its first full year of data collection. Network-wide, data completeness was 85.5%, with FS-operated sites reporting 84.1% completeness. Some sites were re-equipped with long-life (6-month) inlet filters in 2022. This will improve data quality by not requiring monthly inlet filter membrane changes and extending site-visit intervals for operators. Lab testing indicated adequate performance from the new filters. All sites will be so equipped in 2023 and visits will only need to be made quarterly.

A few sites experienced significant data losses due to malfunction (Table 1, below). Analyzer malfunction and an unexplained datalogger failure resulted in no data being collected after October 31<sup>st</sup> at Little Mountain (Uinta Basin, UT). Grand Mesa (CO) again was plagued by a mysterious instrument malfunction and no valid data were collected after July 20<sup>th</sup>. An internal wiring problem shorted the instrument at Dark Canyon (Bear's Ears, UT) and nothing was recorded after August 15<sup>th</sup>. Kenosha Pass experienced an analyzer failure which, regrettably, resulted in missing data from June 1<sup>st</sup> through mid-July.

Year-Round Sites	Forest	Begin Date	End Date	Data Completeness	Notes
Pawnee Buttes	PNG	1 Jan	31 Dec	84.5	
Briggsdale	PNG	1 Jan	31 Dec	88.2	
Kenosha Pass	PSINF	10 Jan	31 Dec	70.8	Analyzer failure (June-July)
Sunlight Mountain	WRNF	1 Jan	31 Dec	98.8	
Little Mountain	Ashley	1 Jan	31 Oct	55.6	Datalogger failure
Hebron Slough	FWS	1 Jan	31 Dec	84.3	
Centennial CASTNet	MBRNF	1 Jan	31 Dec	97.7	
RMNP CASTNet	RMNP	1 Jan	31 Dec	92.9	
Gothic CASTNet	GMUG	1 Jan	31 Dec	99.3	
Dinosaur NM CASTNet	NPS	1 Jan	31 Dec	97.4	
Shamrock	SNJF	1 Jan	31 Dec	90.1	
Mesa Verde CASTNet	NPS	1 Jan	31 Dec	99.3	
Canyonlands CASTNet	NPS	1 Jan	31 Dec	99.1	
GBNP CASTNet	NPS	1 Jan	31 Dec	92.4	
<b>Seasonal Sites</b>					
Deadman Pass	ARNF	1 May	13 Oct	77.9	
Goliath Pk	ARNF	29 May	9 Oct	97.6	
Trout Cr Pass	PSINF	30 Apr	9 Oct	96.2	
Kremmling	BLM	26 Apr	23 Oct	96.3	
McClure Pass	GMUG	29 Apr	3 Oct	97.4	
Ripple Cr Pass	WRNF	1 May	1 Oct	92.6	
Grand Mesa	GMUG	1 Apr	20 Jul	47.6	Unknown analyzer malfunction
Norwood	SJNF	20 Mar	8 Oct	97.8	
Douglas Pass	BLM	17 Mar	4 Oct	99.0	
Snowbird	WCNF	17 Mar	5 Oct	98.4	
Dark Canyon	MLSNF	28 Apr	15 Aug	59.8	Wiring problem
Ruby Guard	HTNF	18 Mar	6 Oct	91.1	

**Table 1. 2021 Network performance**

### III. Data Summary:

Ozone hazard to vegetation and human health may be assessed using a number of different metrics. The table below (Table 2) lists daytime and overnight averages, the maximum and fourth-maximum daily 8-hour averages, and the highest observed 3-month daytime W126 values. For vegetation, EPA (EPA 2015) considers 17ppm-hr to be a general threshold for foliar damage to vegetation.

Year-Round Sites	Average O <sub>3</sub> (ppb)		Daily 8-hour O <sub>3</sub> (ppb)				Cumulative O <sub>3</sub> (ppm-hr)	
	Daytime	Overnight	Max	Date	4 <sup>th</sup> Max	Date	Max W126	Period
Pawnee Buttes	47.4	39.6	71.1	13 Jun	68.9	16 Jun	14.8	Jun-Aug
Briggsdale	43.3	25.4	73.4	15 Jul	71.9	13 Jun	17.3**	Jun-Aug
Kenosha Pass	49.9	46.9	101.5	12 May	66.9*	21 Apr	12.3*	Mar-May
Sunlight Mountain	47.6	47.8	70.1	26 Apr	63.6	21 May	9.3	Mar-May
Little Mountain	46.6	46.2	63.7*	27 Apr	62.0*	10 May	No data	
Hebron Slough	45.9	31.0	65.2	21 Jun	62.8	27 Apr	7.5	Apr-Jun
Centennial CASTNet	48.3	47.9	89.7	10 Sep	66.6	9 Aug	8.8	Apr-Jun
RMNP CASTNet	48.8	45.1	72.7	7 Sep	69.8	9 Aug	12.2	Jun-Aug
Gothic CASTNet	47.2	39.4	73.6	15 Jun	65.3	30 Apr	10.4	Apr-Jun
Dinosaur CASTNet	44.1	30.6	65.0	9 Aug	63.4	18 Jul	10.2	Jun-Aug
Shamrock	45.3	38.0	71.1	1 Jun	63.4	18 Jul	9.4	Apr-Jun
Mesa Verde CASTNet	45.9	43.0	66.9	20 Jun	64.1	20 Jul	10.3	Jun-Aug
Canyonlands CASTNet	44.9	43.6	65.1	26 Apr	63.5	28 Apr	8.6	Jun-Aug
GBNP CASTNet	44.1	43.1	64.6	17 Jun	61.6	16 Jun	8.4	Jun-Aug
<b>Seasonal Sites</b>								
Deadman Pass	52.3	51.1	78.0	16 Jun	70.8	15 Jun	12.7*	May-Jul
Goliath Pk	51.4	48.7	78.5	16 Jun	73.3	14 Jun	10.4	Jun-Aug
Trout Cr Pass	50.7	45.5	76.4	15 Jun	69.1	29 May	10.6	May-Jul
Kremmling	45.1	22.7	67.4	20 May	63.7	21 Jun	7.0	May-Jul
McClure Pass	51.0	46.7	71.5	1 May	67.6	1 Jun	11.6	May-Jul
Ripple Cr Pass	47.7	49.8	73.1	15 Jun	64.0	21 Jul	6.0	Jun-Aug
Grand Mesa	49.4	48.3	64.8*	26 Apr	61.7*	1 Jun	7.4*	Apr-Jun
Norwood	48.5	33.8	73.6	15 Jun	67.0	18 Jul	10.9	May-Jul
Douglas Pass	49.8	49.4	73.4	15 Jun	66.8	9 May	9.2	May-Jul
Snowbird	53.8	53.4	79.5	9 Aug	74.9	9 Sep	18.0**	Jul-Sep
Dark Canyon	49.8	40.5	66.5	21 Jul	62.6	18 Jul	8.0	May-Jul
Ruby Guard	46.4	40.5	65.4	22 Jul	61.5	6 Jun	6.0	Jun-Aug

**Table 2: Summary statistics for all 2022 Sites. “Average O<sub>3</sub>” is the mean of ozone readings between 8 a.m.-8 p.m. (Daytime) and 8 p.m.-8 a.m. (Overnight) for the entire growing season (April-September). “Daily 8-hour O<sub>3</sub>” reports the days on which the highest and 4<sup>th</sup>-highest 8-hour averages were recorded (see text for further explanation).**

\*indicates site where missing data precluded complete assessment; actual peak may not have been observed.

Deployment dates listed in Table 1.

\*\*Value reflective of potential impact of long-term vegetation exposure; see text.

### III. Discussion:

Since the severe wildfire season of 2020, air quality has improved regionally. Data from 2022 support this trend, with surface ozone observations at generally benign levels throughout the growing season and year-round at continuously monitored sites.

Of the network's sites for which the NAAQS 3-year average design value could be calculated, seven remain at levels which constitute nonattainment (see Table 3 below). Four of these sites (Snowbird, Pawnee Buttes, Briggsdale, RMNP CASTNet) are within EPA's current nonattainment areas. Deadman Pass, northwest of Fort Collins, CO, is outside the current nonattainment area of Larimer County. Kenosha Pass (Park County, CO) and Goliath Peak (Clear Creek County, CO), both proximate to the Denver metropolitan area, are not in counties designated for nonattainment.

Site	2020	2021	2022	2020-2022 Avg
<b>Year-Round Sites</b>				
Pawnee Buttes	62.8	79.5	68.9	70.4
Briggsdale	67.1	78.2	71.9	72.4
Kenosha Pass	71.8	76.5	66.7	71.7
Sunlight Mtn	64.7	68.7	63.6	65.7
Little Mtn	68.4	76.7	62.0	69.0
Hebron Slough		71.6	62.8	
Centennial CASTNet	61.6	72.1	66.6	66.8
RMNP CASTNet	67.8	77.8	69.8	71.8
Gothic CASTNet	63.4	65.0	65.3	64.6
Dinosaur CASTNet	61.0	68.1	63.4	64.2
Shamrock	62.3	66.4	63.4	64.0
Mesa Verde CASTNet	64.6	67.8	64.1	65.5
Canyonlands CASTNet	61.5	69.1	63.5	64.7
GBNP CASTNet	66.3	68.6	61.6	65.5
<b>Seasonal Sites</b>				
Deadman Pass	67.9	83.3	70.8	74.0
Goliath Pk	72.9	84.1	73.3	76.8
Trout Cr Pass	65.6	72.8	69.1	69.2
Kremmling	65.4	67.7	63.7	65.6
McClure Pass	63.9	68.4	67.6	66.6
Ripple Cr Pass	64.0	72.0	64.0	66.7
Grand Mesa	62.6			
Norwood	67.8	67.4	67.0	67.4
Douglas Pass	62.2	71.6	66.8	66.9
Snowbird	70.6	81.8	74.9	75.8
Dark Canyon	64.4		62.6	
Ruby Guard	61.8	75.4	61.5	66.2

**Table 3. Fourth-maximum daily values (MDA8) and three-year averages. Red indicates exceedance of NAAQS. Values for 2020 exclude peak wildfire impacts of late August of that year.**

Only a few periods of elevated ozone occurred on the network in 2022. Two regionally-synchronous events were observed in mid- and late April, with the first event more noticeable at eastern and northern sites (especially the Front Range). The later event was more pronounced at western and southern sites. Neither event produced hazardous levels of surface ozone. Two events in late spring (mid-June), of greater amplitude than those of April, were noted at all sites east of the Continental Divide and several West Slope sites. These two events produced longer periods of elevated ozone which may have had some vegetation impact at high-elevation sites (e.g., Goliath Peak, RMNP CASTNet).

The first three weeks of July saw an unusual phenomenon at many western sites, where ozone steadily increased each day and peaked around July 20<sup>th</sup>. A few sites neared or exceeded 70 ppb readings during this time. Several sites on the West Slope and Colorado Plateau recorded their highest readings of the year in the third week of July.

An event centered on August 9<sup>th</sup> impacted the northern Front Range and Great Basin sites. This also was of relatively short duration. Snowbird and Dinosaur CASTNet recorded their highest 8-hour averages of the year, and Centennial and RMNP CASTNets observed their fourth maxima.

Wildfire activity in the western US was down considerably from recent years, although smoke from the extensive Canadian fires did occasionally impact the R2/R4 footprint. Overall, significant ozone impacts on the RMRS network were limited to the usual areas subject to urban-source precursors, particularly Snowbird and sites clustered west and north of the Denver urban area.

Passage of a vigorous cold front during the 10-11<sup>th</sup> of September produced spikes in the data at Front Range and other eastern sites. This was a brief but emphatic event that produced the highest 8-hour average readings of the year at Centennial and RMNP CASTNet sites, and Snowbird's fourth-maximum.

#### **IV. Funding.**

<b>Source</b>	<b>Jobcode</b>	<b>Allocated, FY22</b>	<b>Expended</b>	<b>Balance, end FY22</b>
Region 2	NFMG16	7500	5967	1533
ARNF	NFVW10	5000	1669	3331
Ashley NF	NFVW01	0	0	0
Total		12500	7636	4864

**Table 5. Non-RMRS funding sources, expenditures and remaining balance, ozone data collection and analysis, FY21**

#### **V. Acknowledgments:**

RMRS personnel are grateful for the assistance of site operators Helen Kempenich and Andrea Holland (retiree volunteers), Chris Plunkett and Kevin Faucher (Ashley NF), and David Eiriksson (NRCS-Salt Lake City). Their efforts result in increased efficiency of this project and considerable cost savings. RMRS also thanks Clyde Sharp and Bret Harkwell, Air Quality Division, CDPHE, for their efforts to conduct audits at many of the RMRS sites.

## VI. Literature Cited:

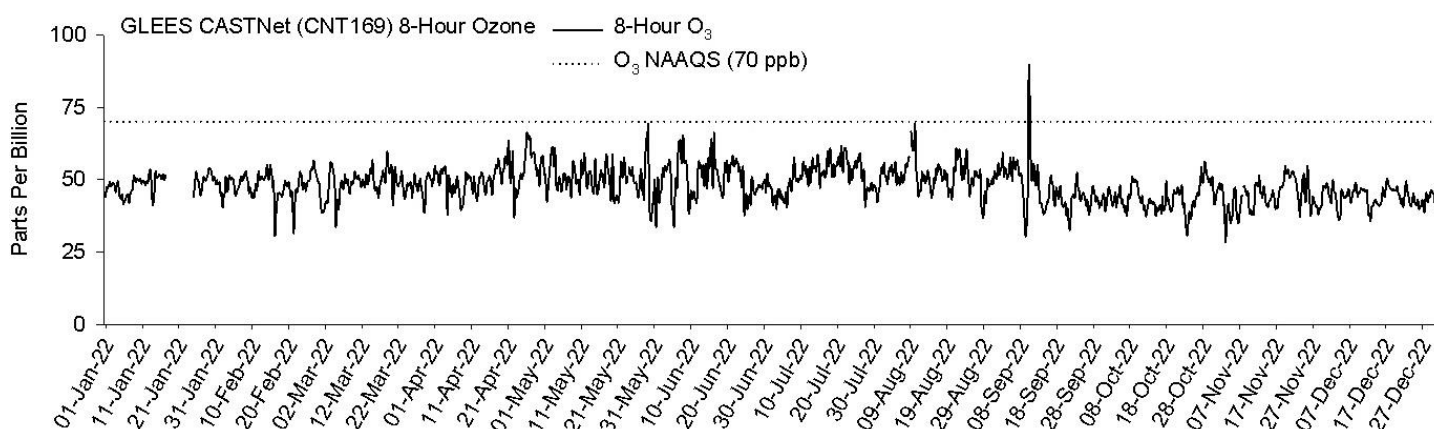
EPA 2015. Overview of EPA's updates to the air quality standards for ground-level ozone.

[https://www.epa.gov/sites/default/files/2015-10/documents/overview\\_of\\_2015\\_rule.pdf](https://www.epa.gov/sites/default/files/2015-10/documents/overview_of_2015_rule.pdf). Accessed 1 Feb 2023.

## Appendix. Individual Site Data and Discussion.

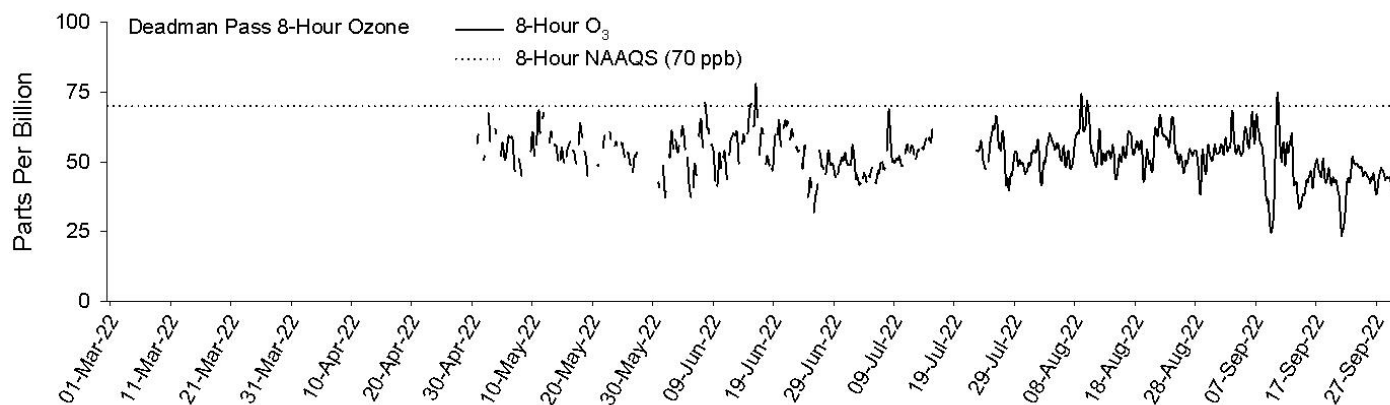
### Region 2 Sites.

1. *Centennial CASTNet*. The site's highest numbers of the year were seen in mid-September, when a brief (about 16 hr) but intense event associated with a cold front passage, yielding one-hour averages that peaked at 94 ppb. Otherwise, ozone was typically benign at this remote, high elevation site with 8-hour averages approaching 70 ppb on only a few occasions in late spring and midsummer.



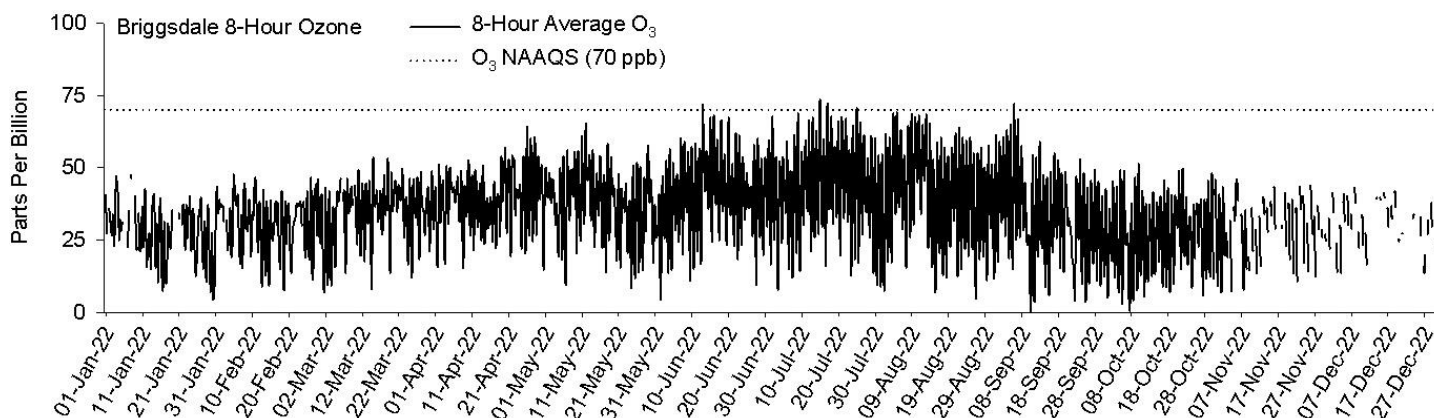
No hazard to vegetation is anticipated at this site, with maximum 3-month daytime W126 at 8.8 ppm-hr.

2. *Deadman Pass*. The same short-duration, high-amplitude event that affected Centennial also was observed at Deadman on 10-11 September. This event was associated with the passage of a strong cold front that affected nearly all of the Front Range and nearby plains. Two other short-duration events (mid-June and mid-August) also produced readings over 70 ppb.



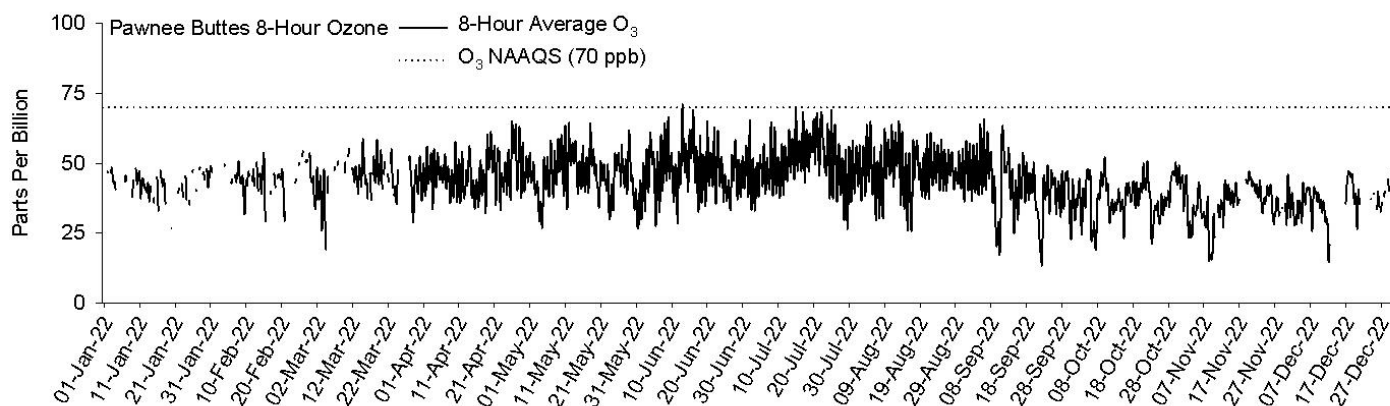
Because of the short duration of elevated ozone events, vegetation was not likely to have been impacted (W126 of 12.7 ppm-hr).

3. *Briggsdale*. Although Briggsdale did not experience any extreme elevated-ozone events in 2022, the consistently high readings (often >60 ppb daytime) through midsummer did create conditions potentially hazardous to the most sensitive plant species. The September event noted above at Centennial and Deadman Pass was of much lower amplitude at Briggsdale.



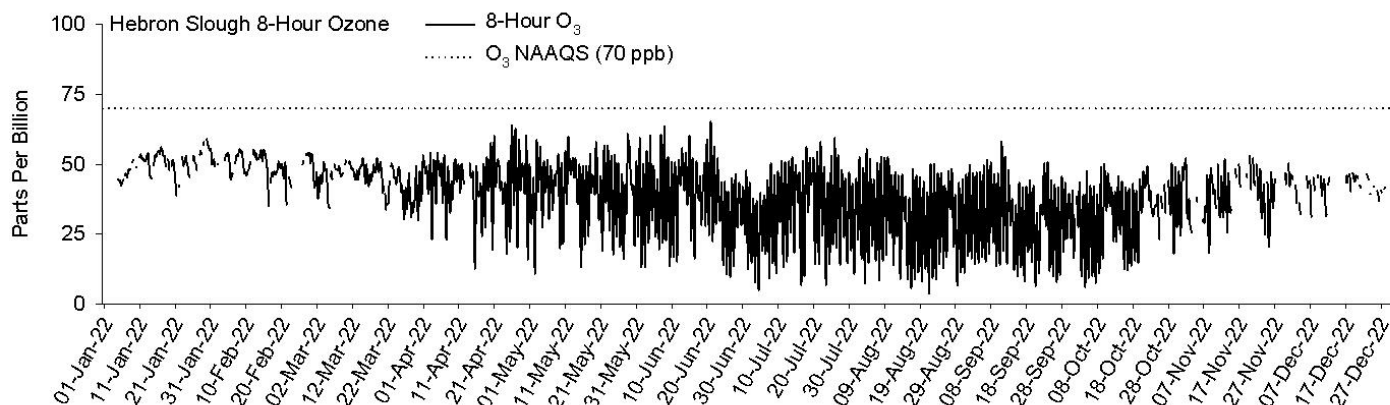
At 17.3 ppm-hr (3-month W126), the June-August period experienced the greatest potential vegetation impact. As is usual for this site, advection of urban-source NO<sub>x</sub> titrated ozone overnight, producing nighttime readings often well below 20 ppb.

4. *Pawnee Buttes*. Surface ozone at both Pawnee National Grassland sites (Pawnee Buttes, Briggsdale) returned to more typical levels after 2021's unusually high observations. As in most years, Pawnee Buttes had lower ozone loading than its sister site 80 km to the west. Only a few 8-hour averages exceeded 70 ppb, and no elevated ozone events of significant duration occurred.



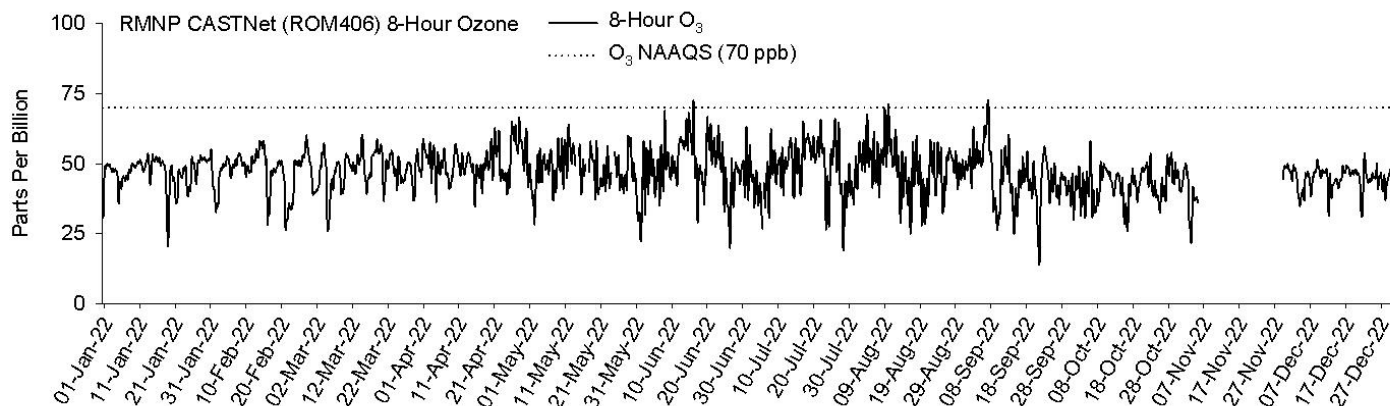
Consistent readings in the 50-65 ppb range in midsummer elevated the 3-month W126 value (14.3 ppm-hr) but this number is below EPA's standard for vegetation hazard.

5. *Hebron Slough*. Ozone at Hebron Slough was down substantially from 2021. Last year, a series of mid- to late-summer events produced several extended periods of elevated ozone, but such events were absent this year. Late spring saw the highest readings, with occasional 8-hour averages of 60-65 ppb. Readings decreased in early summer and remained relatively low for the rest of the year.



Highest 3-month W126 observed was only 7.5 ppm-hr. The mid-September event evident at some Front Range sites was almost entirely absent at this site (and most others west of the Front Range).

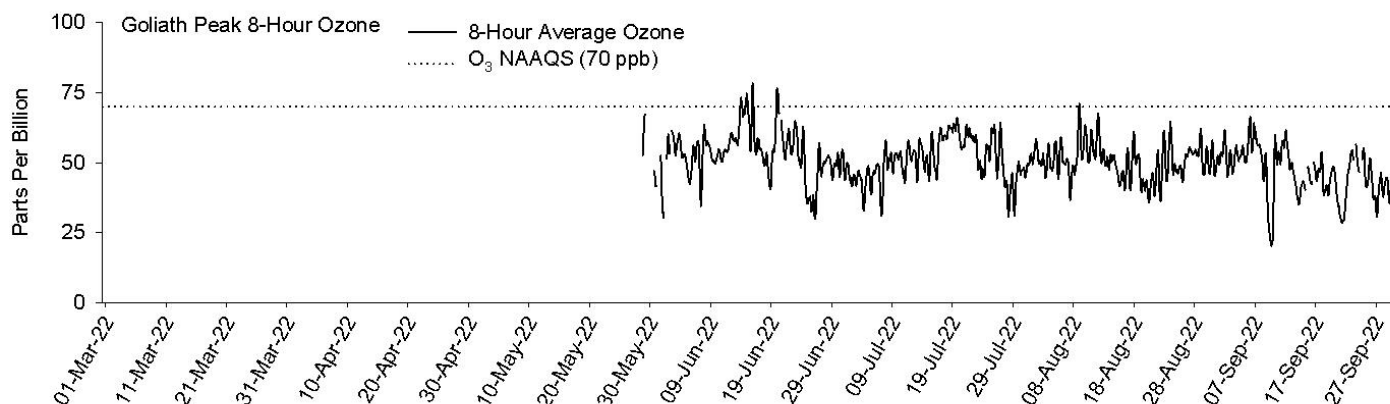
6. *RMNP CASTNet*. Historically one of the most heavily impacted sites, RMNP CASTNet experienced few elevated ozone events in 2022. The September 10-11 event noted at Deadman and Centennial was clearly indicated at RMNP, as were two brief events in late spring and mid-August. Highest design value observed was 69.8 ppb, marking the third year of the last four to be below the 70 ppb NAAQS standard. However, the three-year regulatory figure remained above NAAQS at 71.8 ppb.



At 12.2 ppm-hr, the vegetation exposure metric of 3-month W126 is well below the hazard threshold this year. Readings consistently near the 48.8 ppb daytime average have kept exposure to relatively low levels.

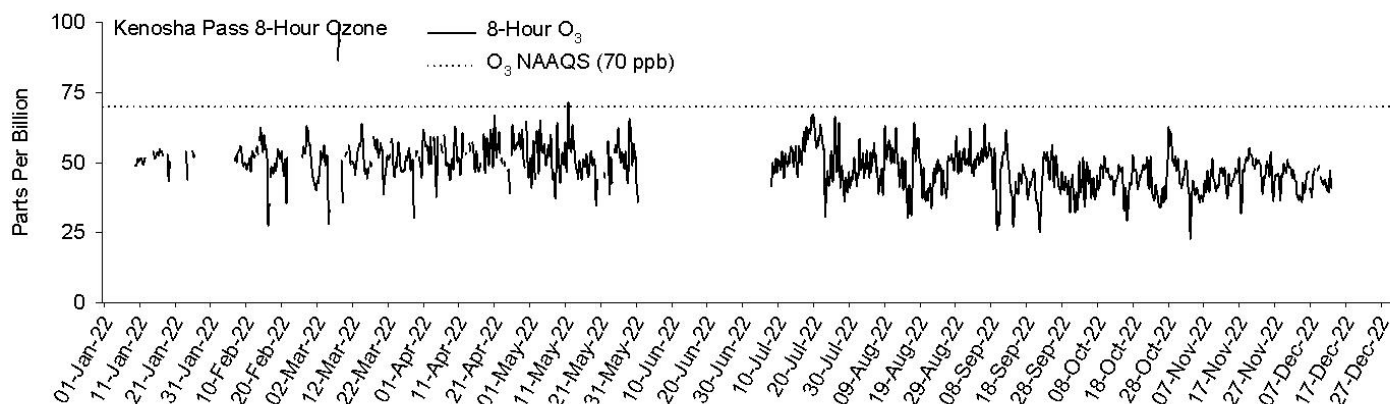


**7. Goliath Peak.** As was the case at RMNP about 100 km north, Goliath Peak experienced an unusually benign year for surface ozone. This site is the highest on the network (near absolute treeline north of Mt. Blue Sky) and is populated by tree species that are robust to the naturally high ozone levels that occur at the site. This year, only three events pushed 8-hour average readings above 70 ppb, two in late spring and a third in mid-August. However, the current design value (73.3 ppb) and those of the previous two years remain well above NAAQS.



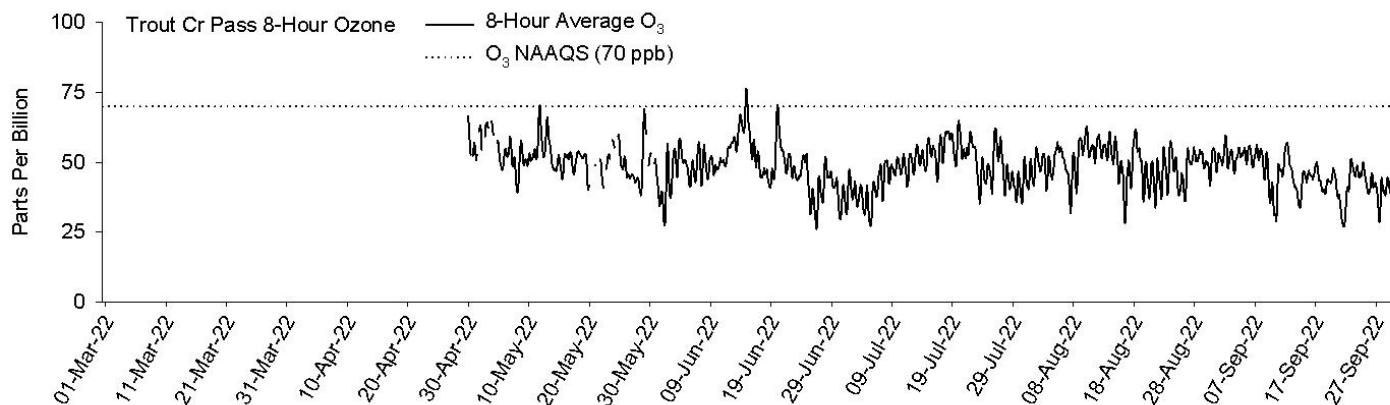
Goliath Peak remains among the most-impacted sites, although this year's maximum W126 figure, 10.4 ppm-hr, is well below the hazard threshold for the area's sensitive species (e.g., quaking aspen). Since 2018, W126 exceeded 17 ppm-hr only in 2020 (17.5 ppm-hr). This encouraging trend indicates decreasing likelihood of foliar damage.

**8. Kenosha Pass.** Only a single event exceeded 70 ppb at Kenosha Pass, although an instrument malfunction prevented observation of ozone in June and early July; this period likely saw additional elevated ozone events (see Trout Creek Pass below). At 66.9 ppb, this year's design value is the lowest observed since 2017, although the three-year average remains above NAAQS at 71.7 ppb.



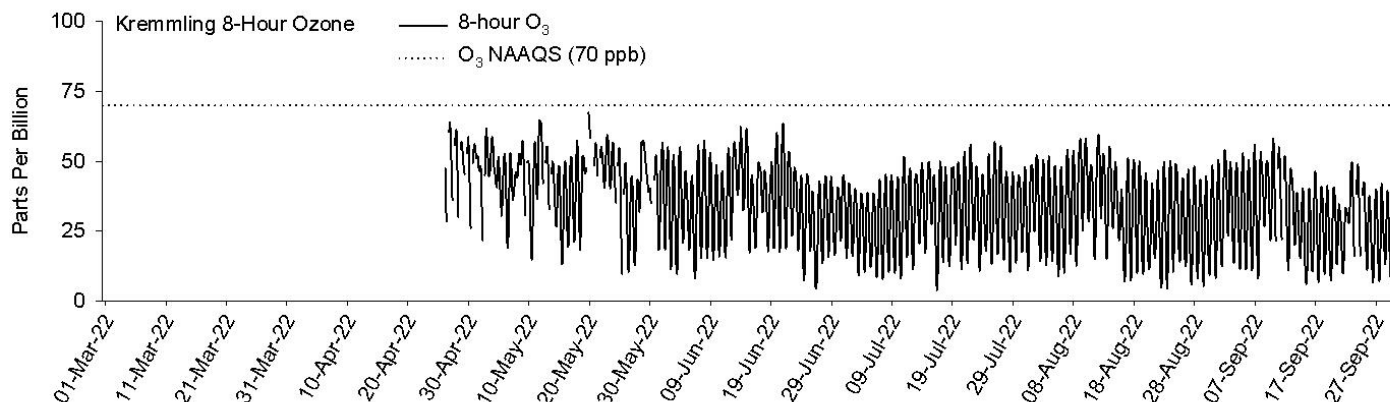
Little vegetation impact was likely in 2022, with readings remaining consistently below 60 ppb during the daytime for most of the year. The springtime figure for 3-month W126, at 12.3 ppb, probably was not the maximum at the site, but is indicative of reduced hazard; highest W126 figures historically have included the months of June and July which were not usable this year.

9. *Trout Creek Pass*. Only three springtime days produced 8-hour averages in excess of 70 ppb at this site in 2022. Two of these days, in mid-June, were during the equipment malfunction at Kenosha Pass (about 90 km north of Trout Creek). The longest event was 15-16 June, where ozone was near or over 60 ppb for 48 hours. Outside of these events, ozone averages remained in the 45-55 ppb range for much of the season.



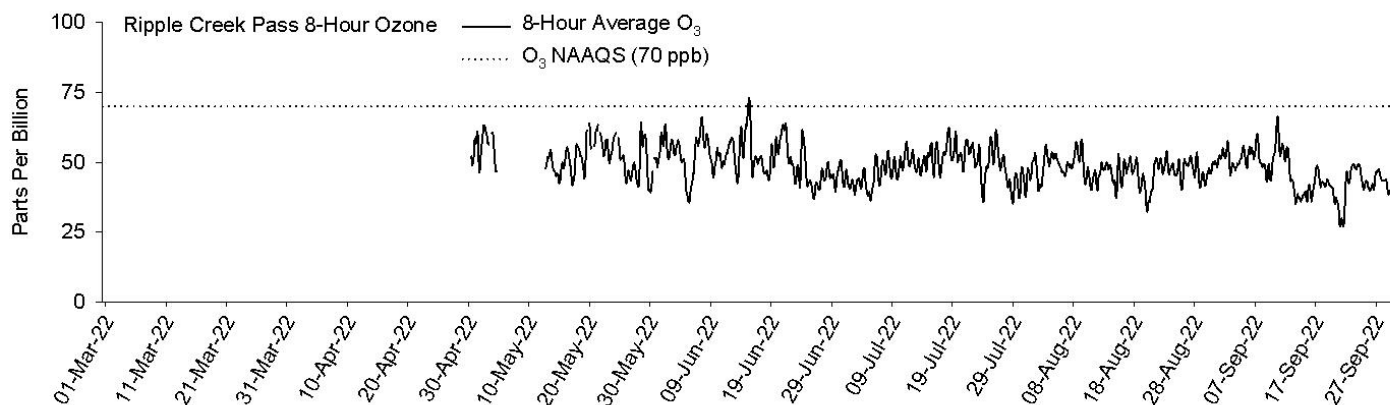
The peak (May-July) W126 mark of 10.6 ppm-hr indicates that none of the elevated ozone events likely had significant impact to vegetation. Trout Creek Pass remains one of the least-impacted sites on the network.

10. *Kremmling*. There were no significant occurrences of elevated ozone at this site in 2022. Modest peaks were observed in late spring, synchronous with events seen elsewhere in the eastern part of the network.



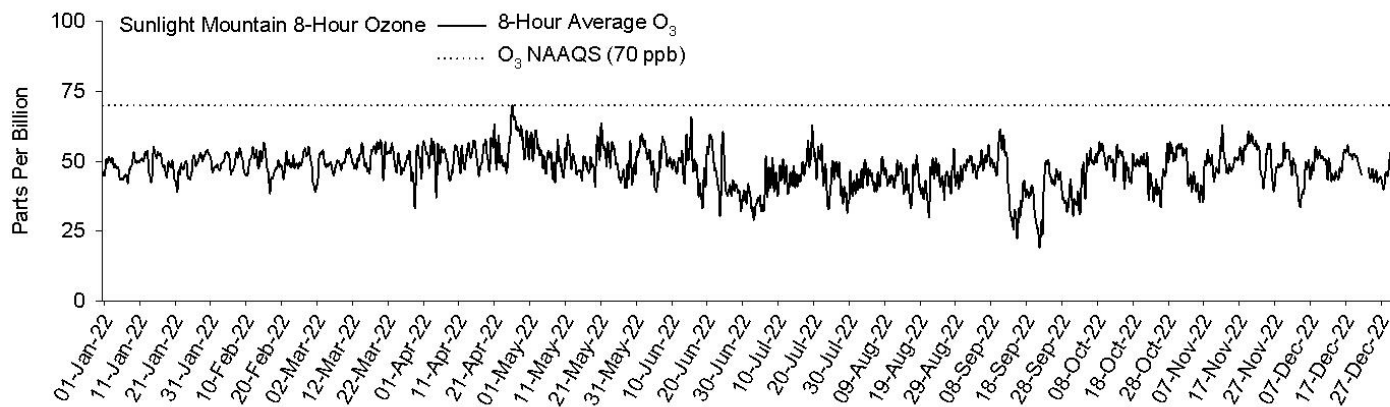
As in previous years, overnight ozone was quite low at this site just east of downtown Kremmling. Vegetation hazard is not noted at this site.

**11. Ripple Creek Pass.** Adjacent to the northern boundary of the Class I Flat Tops Wilderness, Ripple Creek Pass is the oldest site on the network and also one of the least impacted. Only the mid-June event, seen at many other locations, produced 8-hour averages over 70 ppb. The duration of >60 ppb readings was 24 hours. The September 11<sup>th</sup> Front Range event was also observed, but it did not produce hazardous conditions.



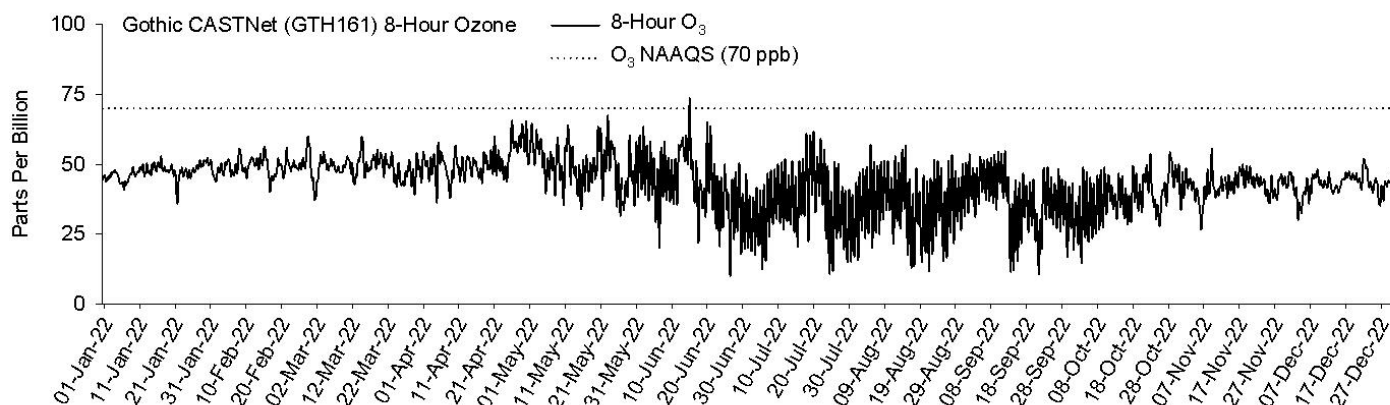
This site tied for the lowest vegetation exposure index (peak 3-month W126 of 6.0 ppm-hr) and this figure marks a retreat from considerably higher readings over the previous five years.

**12. Sunlight.** As with nearly all rural locations on the network, Sunlight experienced relatively little surface ozone in 2022. A 3-hour period on April 26<sup>th</sup> saw hourly readings over 70 ppb, and mid-June saw a few similar numbers. The early September event noted at eastern stations was mostly absent at Sunlight.



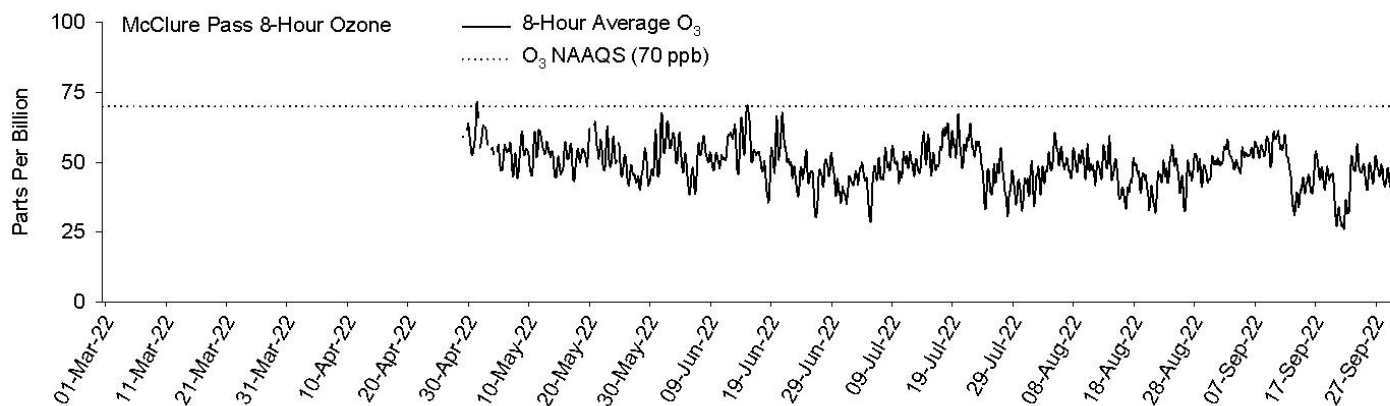
The 2020-2022 period at Sunlight has been very consistent in terms of vegetation exposure. This year's March-May peak W126 of 9.3 ppm-hr follows marks of 9.6 and 9.9 ppm-hr (2020, 2021), all well below hazard threshold. June-August 2018 (18.4 ppm-hr) was the last time the W126 exceeded the threshold.

13. *Gothic CASTNet*. Gothic is adjacent to the Class I Maroon Bells-Snowmass Wilderness. Like most of the network's other high-elevation sites, Gothic experiences little variation (around 50 ppb) through most of the year. Only the June 16<sup>th</sup> event saw 8-hour averages over 70 ppb; this event had ozone over 60 ppb for only 3 hours. Gothic's data otherwise were unremarkable.



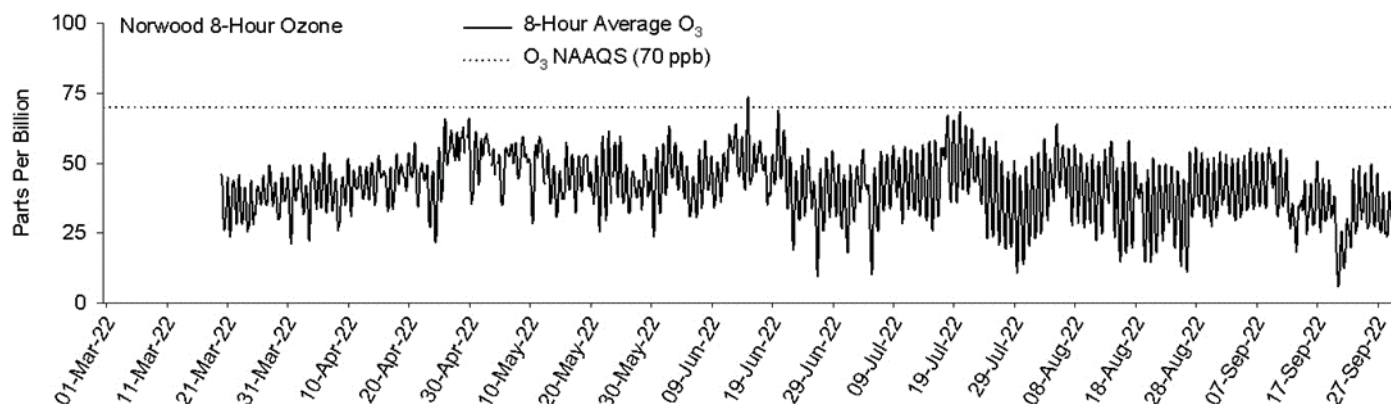
Peak 3-month W126 of 10.4 ppm-hr is consistent with observations in many previous years. Gothic's exposure metric has not reached hazardous levels in any year since 2007 (peak of 15.6 ppm-hr, May-July 2018).

14. *McClure Pass*. Located near the West Elk and Raggeds Wilderness areas, McClure Pass also occupies a location downwind of a potential oil and gas development area. The first day of May saw the season's highest 8-hour averages (71.5 ppb), but the design value (4<sup>th</sup> max, 67.6 ppb) remained below NAAQS. A few minor events occurred later in the springtime, but none approached critical values.



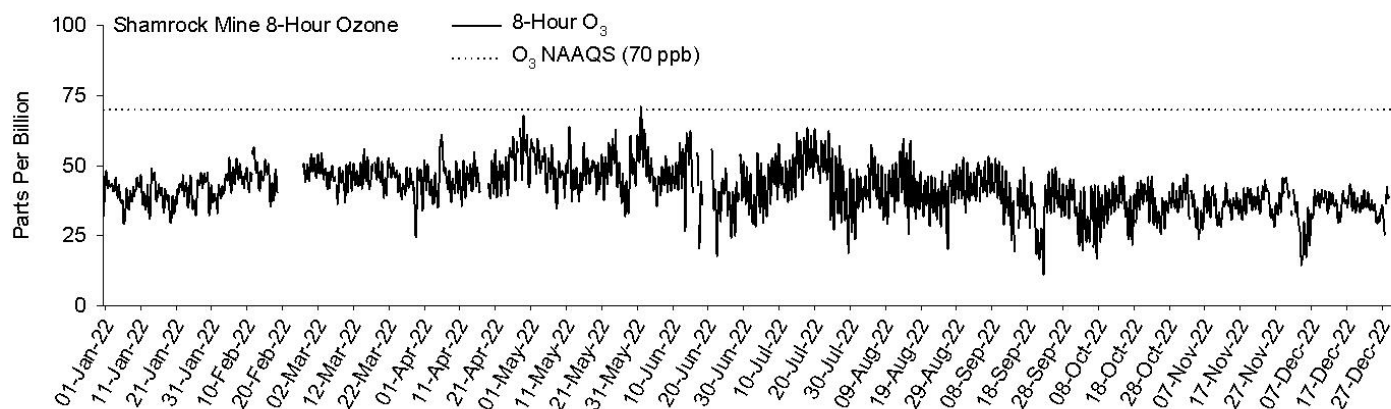
Vegetation hazard at McClure (max 3-month W126 of 11.6 ppm-hr, May-July) remains low, as has been the case since 2018.

15. *Norwood*. Most west slope sites, Norwood included, were affected by the June 15-16<sup>th</sup> event, which peaked here (8-hour average) at 73.6 ppb. A second brief event five days later produced 69.1 ppb. Mid-July saw several days of mid-60s ppb readings, but these relatively high numbers were not sustained for long periods.



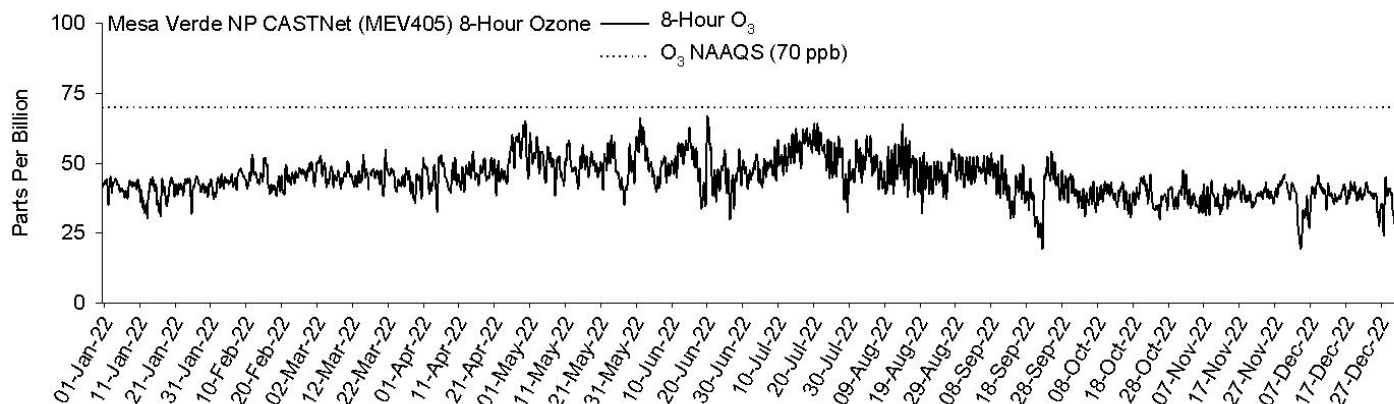
Peak 3-month W126 here (10.9 ppm-hr, May-July) is consistent with the previous two years and does not indicate significant vegetation hazard.

16. *Shamrock*. The mid-June event, which seems to have bypassed the southwestern-most network sites, was not evident at Shamrock. Highest 8-hour averages here occurred two weeks earlier, peaking at 71.1 ppb on June 1<sup>st</sup>. As with most sites, this was not a long-duration event (18 hours) and likely had little impact. Readings for the remainder of the monitoring season hovered in the upper 40's to mid-50s ppb.

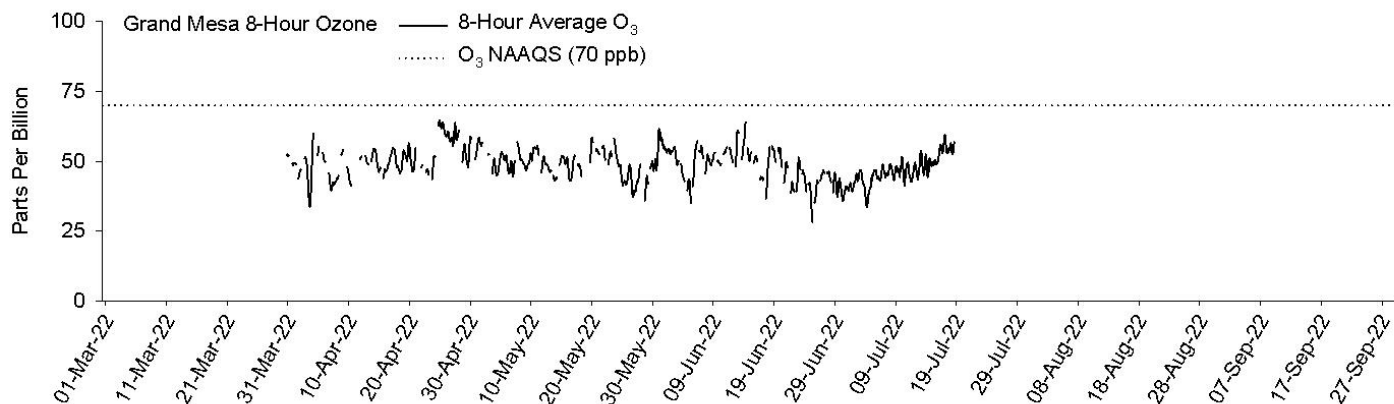


No 3-month W126 values have exceeded the 17 ppm-hr hazard threshold since at least 2016. This year's figure, 9.4 ppm-hr (April-June) indicates continued non-hazardous conditions.

17. *Mesa Verde NP CASTNet*. This Park Service facility remains among the least-impacted sites over the last several years. The trace of the 2022 data very closely parallels that of Shamrock which is about 85 km to the east. This year's design value of 64.1 ppb varies little from those of the previous two years, and MEV remains well below NAAQS.

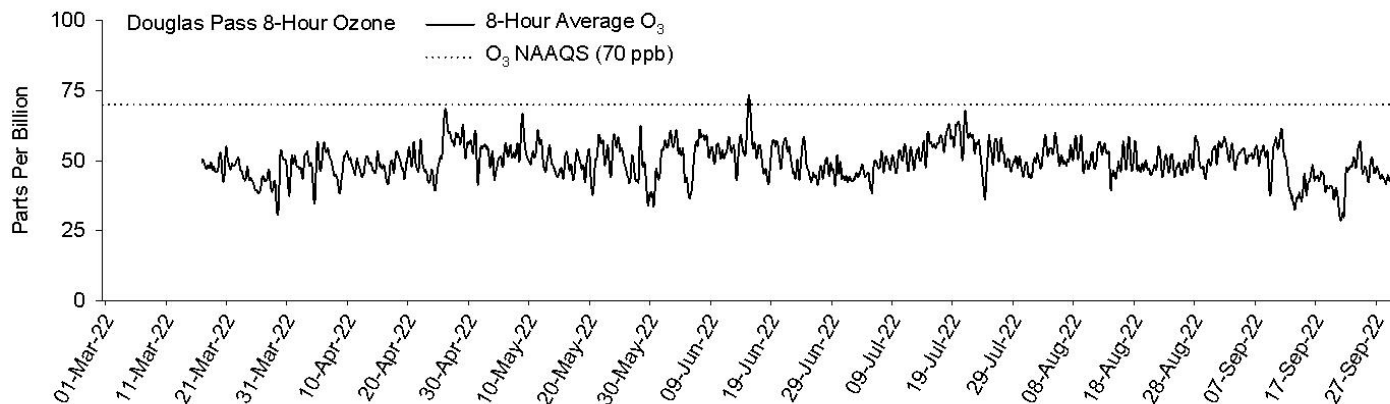


18. *Grand Mesa*. For the third consecutive year, equipment malfunction prevented a complete season of data collection at Grand Mesa. However, data through late July captured most of the year's significant events. Like the rest of the southwestern and west slope sites, surface ozone was modest and no important elevated ozone events occurred. Highest observations occurred on April 26<sup>th</sup>, with the 8-hour average peaking at 64.8 ppb.



Longer-term analysis of ozone trends at Grand Mesa cannot be adequately analyzed at present due to lack of data. Nearby sites (e.g., Douglas Pass, below) do not indicate any emergent vegetation hazard, and it's likely that the same is true of Grand Mesa.

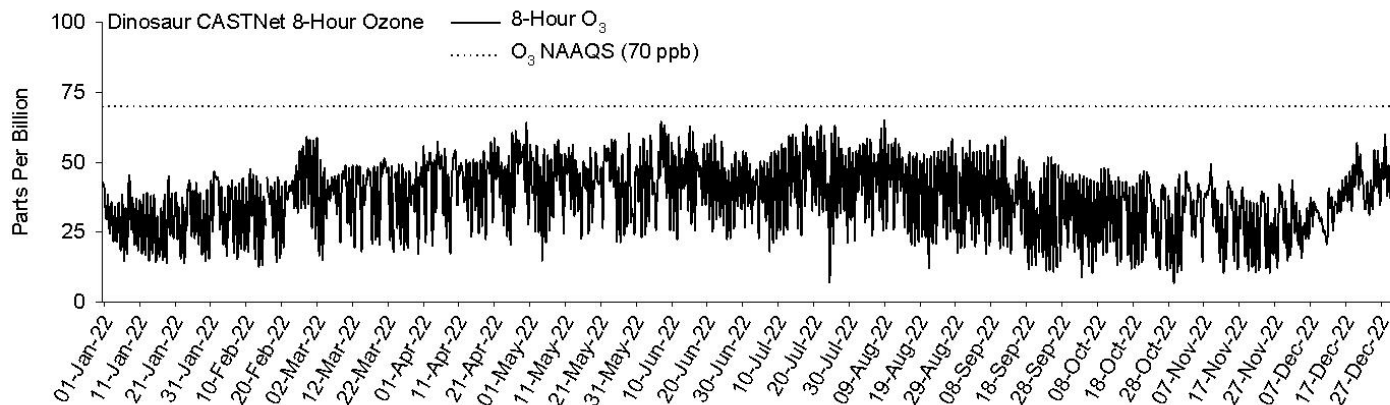
19. *Douglas Pass*. Located upwind of the White River NF and the Flat Tops Wilderness, ozone at this site peaked during the June 15<sup>th</sup>-16<sup>th</sup> event noted mainly in Front Range sites. Peak 8-hour value was 73.4 ppb, but readings exceeded 60 ppb for less than 24 hours. Two other lower-amplitude events occurred in mid-spring. Of note also is the first three weeks of July, which saw a steady, gradual increase in ozone, peaking just under 70 ppb. This event was also observed at several of the southern and western sites.



Vegetation hazard was low at Douglas Pass in 2022. Highest 3-month W126 figure was 9.2 ppm-hr, well below hazard threshold. Although the site has experienced potentially harmful ozone in the past (notably in 2018 and 2021), this year's mark is more typical of past observations.

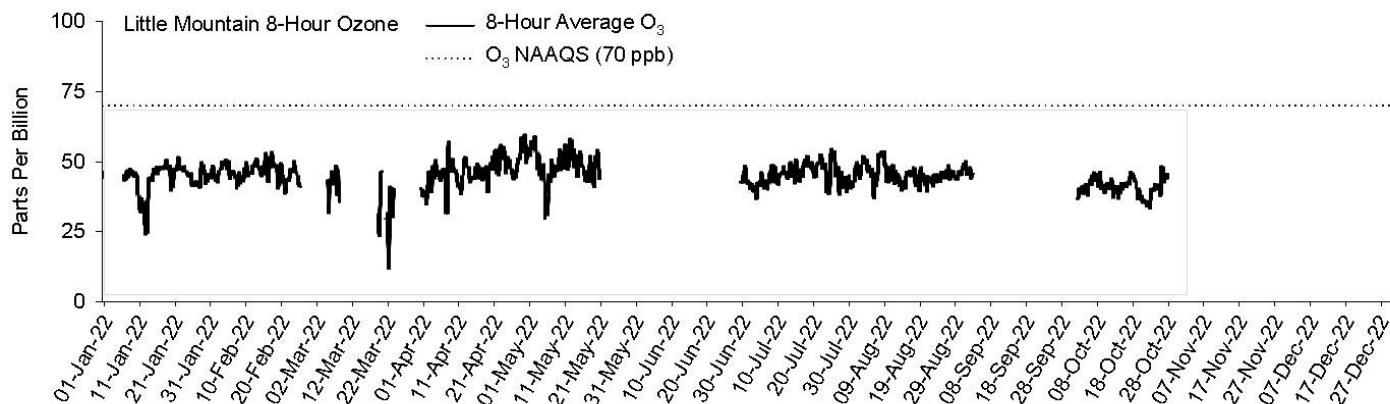
#### **Region 4 Sites.**

20. *Dinosaur National Monument CASTNet*. An unusual event occurred here in from February 26<sup>th</sup> through March 2<sup>nd</sup>, where ozone exceeded 55 ppb during the daytime each day. The Uintah Valley is subject to occasional air stagnation and temperature inversions, and if these conditions prevail during sunny weather, high levels of surface ozone are often observed. However, this period was characterized by relatively cloudy weather, with modest southwesterly winds, and the source of this ozone cannot be determined with certainty. Otherwise, the Dinosaur CASTNet experienced little of note in 2022: peak 8-hour average was only 65 ppb, with 63.4 ppb as the design value. The three-year average of design values now stands at only 64.2 ppb, well within the NAAQS.

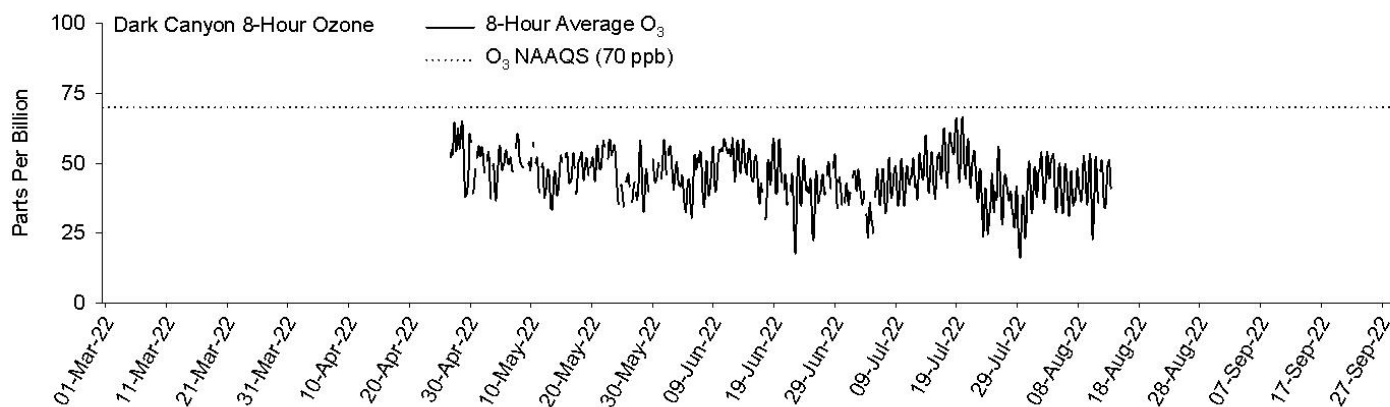


The site experienced potentially hazardous levels of ozone in the past due to a combination of oil and gas field emissions and the aforementioned meteorological features. However, the current peak 3-month W126 of 10.2 ppm-hr (June-August) does not indicate significant hazard. W126 has remained below the hazard threshold since at least 2018.

21. *Little Mountain*. Analyzer malfunction and an unexplained datalogger failure resulted in no data being collected for much of 2022. What data exist suggest that observations at Little Mountain were similar to those at Dinosaur CASTNet, about 60 km east.



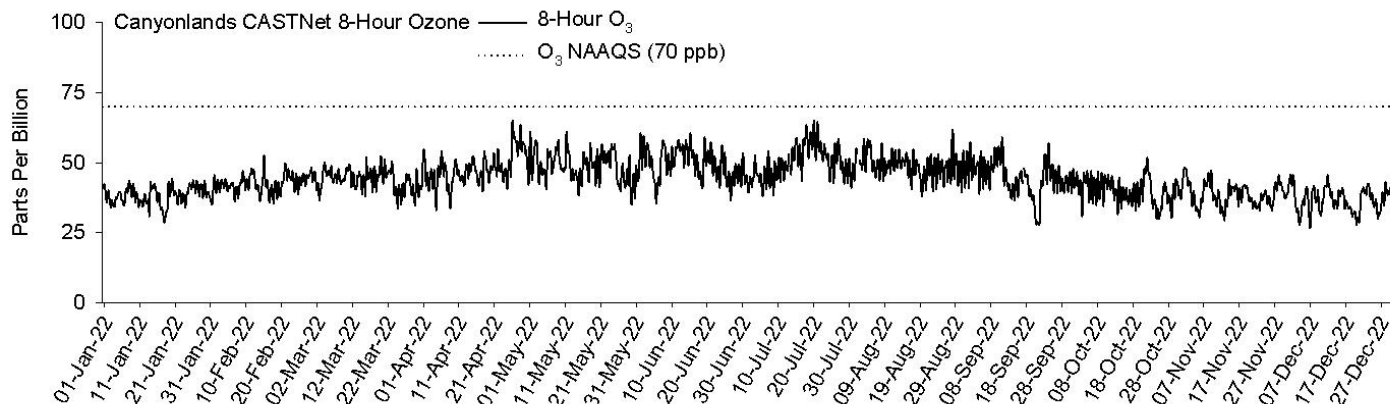
22. *Dark Canyon*. A notable feature of Dark Canyon's data is modest but noticeable overnight titration of ozone. This has been the case of all data since inception of monitoring here in 2014. Most remote, high-elevation sites have little variation between daytime and overnight observations, but Dark Canyon has typically seen about 10 ppb differential. The source of NO<sub>x</sub> that would cause this is not known. Mid-July saw the highest numbers in 2022, with 8-hour averages peaking at 66.5 ppb. Elevated ozone was also observed in late spring (April 30<sup>th</sup>, 65.0 ppb). Electrical issues terminated data collection in mid-August.



Vegetation hazard remains low at Dark Canyon, With the exception of some events induced by nearby wildfires, this has been the case since 2018. This year's peak 3-month W126 of 8.0 ppm-hr (May-July) places it among the least-impacted sites, good news for Bears Ears National Monument's extensive ponderosa pine forests.

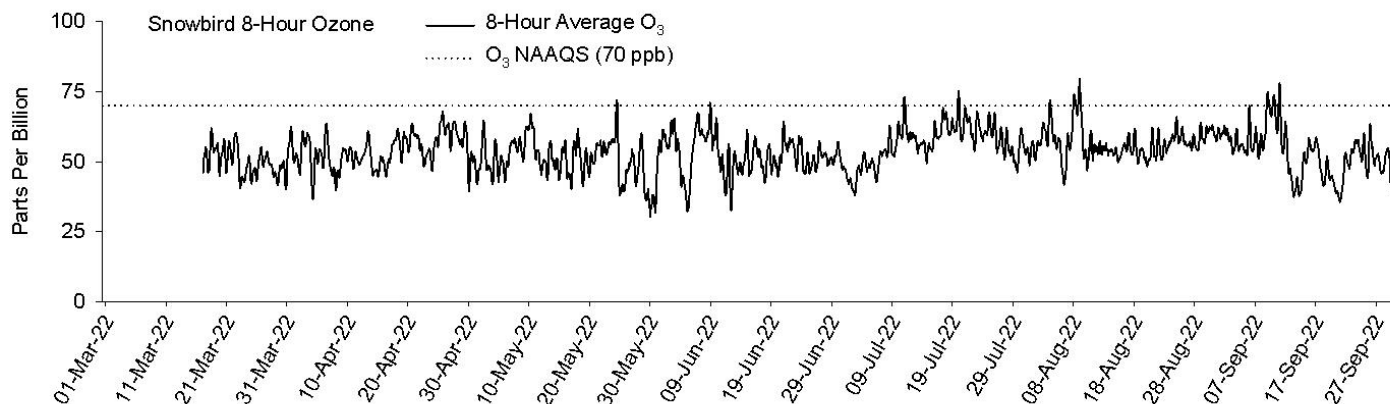


**23. Canyonlands NP CASTNet.** Like Dark Canyon, the Canyonlands National Park CASTNet site is remote from urban-source pollutants and seldom experiences elevated surface ozone. 2022 was no exception, with the site recording only 11 days where 8-hour average ozone exceeded 60 ppb. The maximum of 65.1 ppb occurred on April 26<sup>th</sup>, during an event synchronous with several other western network sites. A second period of somewhat elevated ozone was seen in mid-July, after the three-week ramp-up of ozone also observed elsewhere.



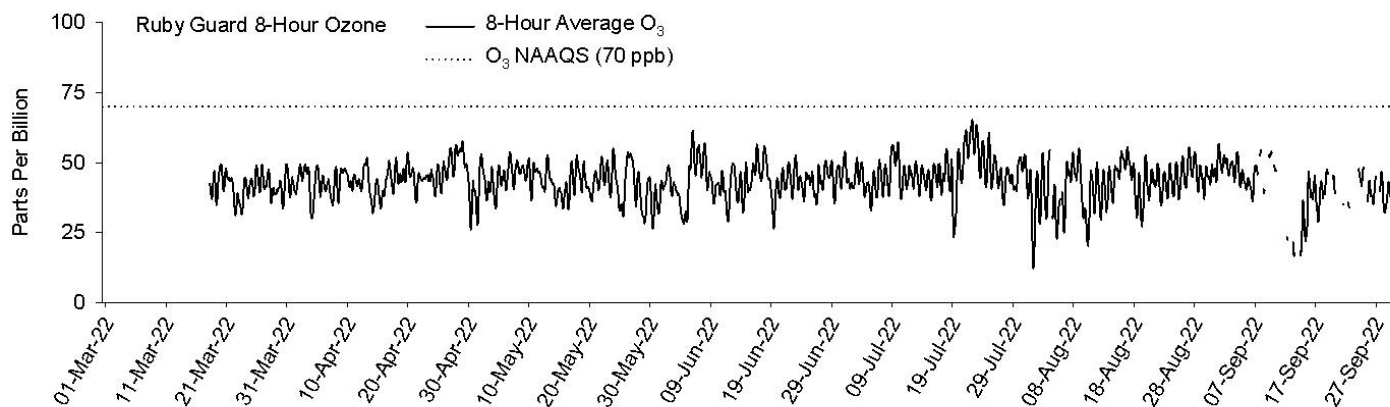
The highest 3-month W126 was 8.6 ppm-hr (June-August) which continues a long record of minimal vegetation hazard.

**24. Snowbird.** In a year of unremarkable ozone data, Snowbird stands out. Located on the Wasatch-Cache-Uinta NF about 20 km east of Salt Lake City, Snowbird (like much of the urban Wasatch Front) is in a current ozone nonattainment county. The 2022 data indicate this status will not change soon. Snowbird's design value, at 74.9 ppb, continues a lengthy string of over-70 ppb design values. The current three-year average, at 75.8 ppb, is well over the NAAQS and, regrettably, echoes much of the data collected in the SLC urban footprint.



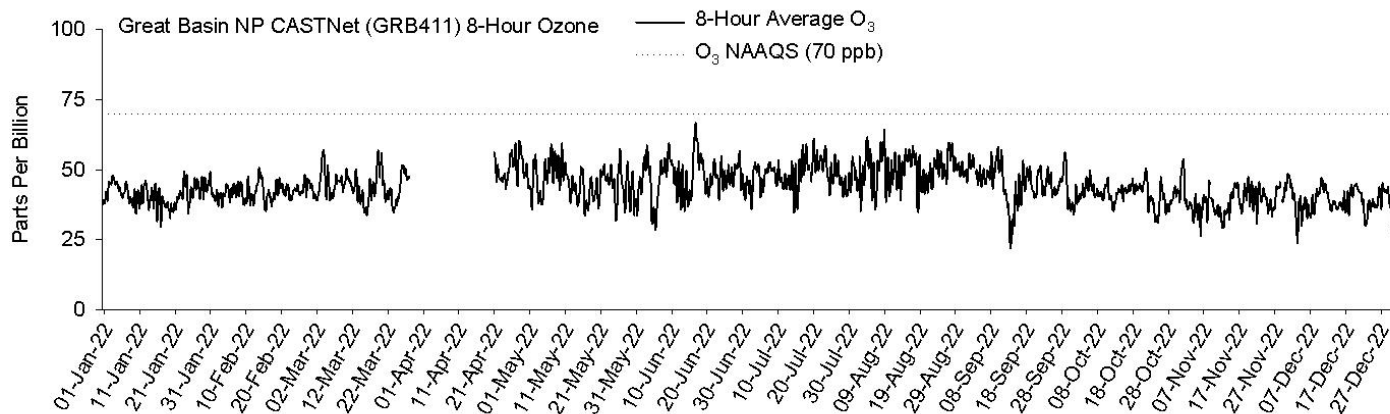
Several significant elevated ozone events occurred in 2022. A 60-hour event 9<sup>th</sup>-11<sup>th</sup> September saw readings over 60 ppb almost continuously, although the year's highest readings occurred on August 9<sup>th</sup> during a shorter event. The August event included a number of one-hour averages well over 80 ppb. Five other shorter-duration events were observed in late spring and early summer. W126 values reflect the extended nature of elevated ozone events, with the 18.0 ppm-hr (July-September) highest on the network. The June-August figure of 17.0 ppm-hr also exceeds EPA's vegetation hazard threshold. The potential for ozone damage to vegetation at Snowbird is significant and ongoing.

25. *Ruby Guard*. About 400 km west of Snowbird, far upstream of the Wasatch Front pollution sources, Ruby Guard's surface ozone remains relatively unvarying and at levels comparable to the western CASTNet sites. Only a single event produced elevated readings for an extended period, in late July, when one-hour averages peaked at 68.4 ppb. No eight-hour averages exceeded 65.4 ppb, and Ruby Guard's three-year average design value of 66.2 ppb is well below NAAQS.



The Ruby Mountains' limber pine forests appear to be safe from imminent ozone damage; highest 3-month W126 this year was only 6.0 ppm-hr, tying Ripple Creek Pass for lowest exposure index in 2022.

26. *Great Basin NP CASTNet*. On June 15<sup>th</sup>, the Great Basin National Park CASTNet recorded a single 70.0 ppb one-hour average, highest for the entire year. No other elevated ozone events of significance occurred at this site in 2022.



Though higher than at Ruby Guard, GRB411's highest 3-month W126, at 8.4 ppm-hr, is below hazard threshold and continues several years of non-hazardous conditions.